

## ABSTRACT OF THE DISCLOSURE

A semiconductor device includes a hetero grain stack gate (HGSG). The device includes a semiconductor substrate having a surface, a gate insulating layer formed over the surface of the semiconductor substrate, and a gate electrode formed over the gate insulating layer, wherein the gate electrode includes a lower poly-SiGe layer having a columnar crystalline structure, and an upper poly-Si layer having a random crystalline structure. In one embodiment, the gate electrode includes a lower poly-SiGe layer having a columnar crystalline structure, an intermediate layer having an random crystalline structure, and an upper poly-Si layer having a columnar crystalline structure. A method of manufacturing a semiconductor device having an HGSG comprises depositing a gate insulating layer over a surface of a semiconductor substrate, depositing a lower poly-SiGe layer having a columnar crystalline structure over the gate insulating layer, depositing an amorphous Si layer over the lower poly-SiGe layer, and crystallizing the amorphous Si layer to obtain an upper poly-Si layer having a random crystalline structure.